METHODS OF ESTIMATING POPULATION SIZE -- MARK-RECAPTURE

The most fundamental task in population ecology is to determine or estimate population size. One way to estimate the size of a population is to capture and mark individuals from the population, release them, and then resample to see what fraction of individuals carry marks. Various techniques with accompanying equations are then used to approximate population size. For this lab exercise, we will be illustrating two techniques by running a simulation and capturing "organisms" and marking them, returning them to the "population", and subsequently resampling the poulation.

We will use two methods for estimating population size: (1) the **Petersen Method**, and (2) the **Modified Schnabel Method**. Both methods are useful when sampling **closed populations** -- those populations that do not change in size at all or very much during the study period due to births, deaths, immigration,or emigration. **Open populations** are those that can fluctuate in size and composition due to the same parameters, especially for animals that are mobile (emigration and immigration).

Petersen Method

This is a simple mark-and-recapture method based on a single episode of marking animals and a second single episode of recapturing individuals. Our basic procedure will be to first collect and mark a number of individuals from our "egg reject" population and then resampling the population and tallying the number of marked and unmarked eggs. We will be using an "organism" that has six color morphs and three sizes.

Three measures are needed to estimate N (population size):
M = the number of individuals marked in the first sample
C = total number of individuals captured in 2nd sample
R = number of individuals in 2nd sample that are marked

These are placed into the following equation:

$N = CM / R$, or if R is greater than 7,

$N = [(M + C)(C+1) / (R + 1)] -1$

Assumptions of Petersen Method

(1) The population is "closed", so N is constant.
(2) All animals have the same chance of getting caught in the first sample.
(3) Marking individuals does not affect their catchability.
(4) Animals do not lose marks between the two sampling periods.
(5) All marks are reported on discovery in the second sample.

Modified Schnabel Method

This method is merely an extension of the Petersen Method but uses multiple sampling to derive an estimate of population size. For each sample, we need the following measures:
C_t = total number of individuals captured in sample *t*
R_t = number of individuals already marked in sample *t*
U_t = number of individuals newly marked and released in sample *t*
M_t = total number of individuals marked in population at sample *t*

The following equation is used, based on a modification by the Schumacher and Eschmeyer Method:

$$\mathbf{N = C_tM_t^2 \ / \ R_tM_t)}$$

Assumptions for Modified Schnabel Method are the same as for the Petersen Method

Problem Sets:

(1) Calculate estimated total population size based on the Petersen Method.

(2) Using the Petersen Method, calculate separate estimates for each size class of the population.

(3) Calculate estimated total population size based on the Modified Schnabel Method.

(4) Using the Modified Schnabel Method, calculate separate estimates for each size class of the population.

(5) Calculate estimated population size by color for both the Petersen and Modified Schnabel Methods.

(6) What statements can you make regarding potential biases or differential estimates of population size based on color and size?

(7) Assess which of the above methods is more accurate relative to the true population size (calculate for total population size, population size by size class, and population size by color) using the following equation:

Calculating Accuracy

A = ± 100 [(Estimated pop. size minus true pop. size) / True pop. size]

True population size

Color

Size	Green	Orange	Yellow	Pink	Blue	Purple
Small	**15**	**15**	**15**	**16**	**16**	**14**
Medium	**24**	**24**	**24**	**24**	**24**	**23**
Large	**8**	**7**	**7**	**8**	**8**	**8**

Total = 280